GENERAL AVIATION DATA LINK SURVEY ANALYSIS
FLIGHT SCHOOLS

RICHARD R. OLSON

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16. Abstract

The Federal Aviation Administration (FAA) is interested in integrating Data Link communications technology into the General Aviation (GA) community. But, how much does the GA community know about the Data Link concept, the services that are possible, and the advantages of Data Link? This report contains an analysis of a survey that was conducted at five Part 141 Flight Schools.

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EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) is interested in implementing alternatives to the current voice communication between pilots and air traffic management. One alternative is Data Link. The use of Data Link is expected to enhance flight safety and to decrease pilot workload in commercial, air transport, and General Aviation (GA).

In order to obtain information from the potential end users of the proposed Data Link system, a survey was produced to determine the user's preferences for services that can be presented through Data Link. Information regarding the pilot's experience and type rating was also collected.

The survey was distributed at five Part 141 flight schools during 1992. The results of this survey indicate that the student pilot's current knowledge about Data Link was limited, and therefore, they were unable to determine the services that would be useful to them. However, the students did indicate concerns that too much automation, coupled with fewer human-to-human interactions, might lead to a negative impact on the air traffic system. They were also reluctant to "buy into" Data Link without a greater understanding of the cost/benefit question.

1. INTRODUCTION.

The Federal Aviation Administration (FAA) is interested in integrating Data Link communication technology into the General Aviation (GA) community. This interest is driven by a desire to enhance GA flight safety and to decrease pilot workload.

In order to ensure that the Data Link system developed is "needs driven," the FAA went to the user community to obtain input from GA pilots regarding the type of information, either air traffic control (ATC) or related services which the GA pilot would like to have presented through Data Link. Potential users of the system were asked to participate in a survey that was developed to collect this information. Surveying pilots is directed as an initial step in developing system requirements.

The survey was mailed to five Part 141 flight schools: Embry-Riddle Aeronautical University, Florida Institute of Technology, McGuire Air Force Base Aeronautical Club, Purdue University, and University of North Dakota. A copy of the survey is provided in appendix A. Representatives of each school distributed the surveys to students. This report presents the results of responses to the GA pilot survey.

2. BACKGROUND.

Prior to this investigation two other sectors of the GA community were asked to participate in similar surveys aimed at collecting information on the ATC and related services GA pilots would like provided through Data Link. The first data collection effort was conducted at the 1992 Experimental Aircraft Association (EAA) Airshow in Oshkosh, Wisconsin. The findings from this effort indicated that pilots would like Data Link to provide Weather Briefings, Automated Terminal Information System (ATIS), and Notice(s) to Airmen (NOTAMS)/Pilot Reports (PIREPS). In addition, they prefer the information to be provided on a cathode ray tube (CRT)/flat panel display. Pilots provided a number of concerns regarding the economically justifiability, practical achievability, and merits of the system.

The second survey effort was conducted during the 1992 National Business Aircraft Association (NBAA) Convention in Dallas, Texas. The findings of this data collection effort indicated that pilots would like Data Link to provide ATIS, NOTAMS/PIREPS, Weather Briefings, and instrument flight rules (IFR) Operations. They also would prefer the Data Link information to be presented on a CRT/flat panel display with an optional print function. Pilots had few comments regarding the economics and practicality of the system, however they provided several display format comments.

3. PURPOSE.

The purpose of this paper is to respond to the following:

a. What air traffic services do GA pilots need over Data Link?

b. How could the desired services be presented to the pilot?

4. METHODOLOGY.

A survey was developed to collect information from GA pilots regarding the type of ATC and related services they would like provided through Data Link. In order to stratify the data, the survey requested respondents to provide data describing: certificates and ratings, flight experience, current involvement in aviation, aircraft ownership, ATC, and related services currently utilized, and ATC and related services they would utilize if Data Link were provided.

Draft versions of this survey were distributed to an aviation safety seminar, Fixed Based Operators (FBOs), a flight school, and Aircraft Owners and Pilot Association (AOPA) representatives. Revisions based on the data and comments received from these sources were incorporated into the final version of the survey document prior to distribution to the five flight schools.

5. RESULTS.

Findings are addressed in two areas: quantitative analysis and qualitative analysis. The quantitative analysis section presents the results from pilots responses to questions 1-7 of the survey, and a comparative analysis between what ATC and related services pilots currently use and what ATC and related services they would like Data Link to provide. The qualitative analysis section presents comments that pilots provided in the comments section of the survey. A total of 161 pilots completed and returned the surveys.

5.1 QUANTITATIVE ANALYSIS.

This section will present an overview of the quantitative survey results. Questions 1, 2, and 3 present results for the level of pilot certification/rating, flight experience, and their current involvement in aviation. Questions 4, 5, 6, and 7 present results relating to aircraft ownership, current use of ATC and related services and pilots desired use of ATC and related services with Data Link, as well as the desired format display type.

Question 1: Requested pilots to provide information regarding their certificates and ratings. The findings were: 26 percent private, 60 percent commercial, and 14 percent airline transport pilots (see figure 1, appendix C).

The following are the pilots' ratings:

73	percent instrument rated with airplanes
1	percent instrument rated with helicopters
100	percent single engine
55	percent multiengine
4	percent sea plane
2	percent rotorcraft

Student, air carrier, and military pilot categories were included in the survey as a screening mechanism. Individuals that fell into these categories were excluded from the dataset. This was done to ensure that the responses reflected input from the GA pilot population only.

Question 2: Requested pilots to provide information regarding their flight experience. This question was divided into two parts; the first part requested pilots to provide information regarding their total flight experience. The categories were in hours 0-300, 301-1000, and 1001+. These categories were recorded to represent low, medium, and high flight experience levels. The results were: 44 percent for 0-300 hours or LOW, 24 percent for 301-1000 or MEDIUM, and 32 percent for 1001-plus or HIGH (see figure 2, appendix C).

The second part of the question requested pilots to provide the amount of flight time they had logged in the preceding 12 months. Due to the large variance in the response distribution, the best representation of the data is the mode (the most frequently occurring score). The mode for pilot flight time over the past 12 months is 120 hours. When the total flight time for the preceding 12 months is plotted (see figure 3, appendix C) the majority of the respondents (approximately 68 percent) flew less than 200 hours in the preceding 12 months. Approximately 48 percent of the respondents flew less than 100 hours in the preceding 12 months.

Question 3: Requested pilots to respond to, "What is the primary area of your current involvement in aviation?" It will be assumed that since the flight schools were requested to distribute these surveys to their flight students, that the current involvement in aviation for the pilots surveyed is commercial/flight instruction.

Question 4: Stated, "Are you an aircraft owner?" Six percent of the pilots surveyed owned their own airplanes.

Question 5: Requested pilots to check, "Which of the following FAA air traffic control and related services do you routinely use?" The findings are listed in the table 1 and in figure 5 (see appendix C). Those pilots that responded to the other category indicated that they use Automated Weather Observation Service (AWOS), Direct User Access Terminals (DUAT), Hazardous In-Flight Weather Advisory Service (HIWAS), Aerodrome Flight Information Service (AFIS), and weathermation.

TABLE 1. ATC AND RELATED SERVICES - ROUTINELY USED

	USE	DON'T USE
VFR to Controlled Airports	144	17
VFR through Controlled Airspace	143	18
VFR Flight Plan Filing	129	32
VFR Flight Watch	76	85
VFR Flight Following	120	41
Weather Briefings	155	6
NOTAMS/PIREPS	137	24
ATIS	158	3
IFR Operations	118	43
Other	9	

Question 6: Requested, "If the technology necessary for Data Link communications was available, which of the following ATC and related services would you like Data Link to provide?" The categories were reduced from 5 to 3 (see appendix A for survey) such that, an answer of "strongly like" or "like" was transformed into one category of "like," neutral remained neutral, and "don't like" and "strongly dislike" was transformed into one category of "dislike."

Table 2 and figure 6 (see appendix C) presents the findings for each service listed on the survey.

TABLE 2. ATC AND RELATED SERVICES - DATA LINK

	LIKE	NEUTRAL	DISLIKE
VFR to Controlled Airports	73	53	35
VFR through Controlled Airspace	84	45	32
VFR Flight Plan Filing	120	31	10
VFR Flight Watch	88	57	16
VFR Flight Following	76	55	30
Weather Briefings	129	23	9
NOTAMS/PIREPS	139	19	3
ATIS	145	15	1
IFR Operations	108	29	24

Question 7: The last question stated, "What format would you prefer the Data Link information to be displayed?" The responses were:

> Thirty-eight percent of the pilots responded that they would prefer to have the information displayed on a CRT (panel display), 38 percent preferred printed paper copy, and 11 percent chose voice synthesizer. Several of the pilots provided more than one response to this question. Twelve pilots responded that they prefer CRT and printed paper copy; two pilots responded CRT, printed paper copy, and voice synthesizer; two pilots responded CRT and voice synthesizer; and one pilot responded printed paper copy and voice synthesizer. Due to the multiple responses

that 17 pilots provided to this question it is impossible to determine under which format type these responses belong. See appendix B for comments regarding display format.

5.2 COMPARATIVE ASSESSMENT.

A comparative analysis is presented to assess if there is a difference between the pilots use of current ATC and related services with the pilots desire to have the same services presented through Data Link. Table 3 below represents the findings:

TABLE 3. COMPARATIVE ASSESSMENT

	Current System		Data Link System		
ATC and Related Services	Use	No Use	Like	Neutral	Dislike
VFR to Controlled Airports	144	17	73	53	35
VFR through Controlled Airspace	143	18	84	45	32
VFR Flight Plan	129	32	120	31	10
VFR Flight Flight Watch	76	85	88	57	16
VFR Flight Following	120	41	76	55	30
Weather Briefing	155	6	129	23	9
NOTAMS/PIREPS	137	24	139	19	3
ATIS	158	3	145	15	1
IFR Flight Operations	118	43	108	29	24

It appears that ATIS, NOTAMS/PIREPS, Weather Briefings, and visual flight rules (VFR) Flight Plan Filing services are preferred with Data Link.

5.3 QUALITATIVE ANALYSIS.

The comments received from the surveys, are presented in the following categories: practically achievable, economically justifiable, display format, general comments, and merit comments. These are a portion of the comments. The remaining comments can be found in appendix B.

Practically Achievable:

“I feel more comfortable talking to ATC on instrument flight rule (IFR) communications. Can we trust a computer to give us the separation, or clearances for example, during Instrument Meteorological Conditions (IMC)?”

“Total automation of all systems could severely decrease primary student's efficiency and understanding of actual radio communications.”

“I don't think it is the best idea to keep the pilots attention in the cockpit any more especially during these operations where traffic is common.”

“There is a built in safety factor when you monitor a frequency, you can get a big picture which keeps you looking outside for hazards instead of 2 feet in front of you and ATC with complete control. The pilot-in-command needs all the best information possible.”

“I think it would be a great idea for IFR operations because pilots could confirm their clearances on the CRT screen. There has to be a way for the pilot to respond to the clearance though, so that ground control knows the pilot understands the clearance. There should always be a way for a pilot to talk to ATC, but I feel the Data Link will eliminate some errors and radio conqestion.”

Economically Justifiable:

“How expensive is this going to be for aircraft operators?”

“I don't see the benefit portion of the cost/benefit ratio being high enough to implement into GA (excluding business jets and other turbo-props that might be able to make modifications to existing equipment).”

“The communication of information has the potential to improve greatly. However, as with any new technology, cost is probably a drawback. Data Link technology should be an option available to pilots.”

“Data Link would be good, if the cost was kept down.”

“The system sounds like it has potential, but who will ultimately pay the price of installation, the trust fund?”

Display Format:

“I prefer a CRT display format, if Data Link information can be retained and displayed again. I prefer printed paper copy on selected information for pre-flight planning.”

“I feel a printed copy of ATC instructions would be a great help under IFR conditions. Especially in a busy situation when you can't confirm what you heard. It would also seem to be a good safety factor to have a backup of ATC instructions.”

“A CRT should be coupled with some sort of audio system to get the crews attention, especially if the pilot's attention is elsewhere (e.g., flying the plan).”

“A CRT with a print option for the pilot.”

“All three formats would be nice.”

General Comments:

“Great idea, keep it up.”

"If any information about this technology is available, please distribute to flight schools."

"This type of system is long over due."

"This system could be of great benefit to the aviation world and should be funded by the Aviation Trust Fund."

"Data Link sounds like a good idea."

6. DISCUSSION.

6.1 QUANTITATIVE.

The majority of pilots surveyed 60 percent hold commercial pilots certificates, and 73 percent are instrument and single engine rated. Approximately half of the pilots surveyed (55 percent) are multiengine rated.

In addition, pilots surveyed have a range of flight experience low, medium, and high with slightly more in the low category (44 percent) and flew less than 100 hours in the preceding 12 months. All of the ATC and related services in the survey are currently highly used by pilots, however, those that are most frequently used are: ATIS, Weather Briefings, VFR Flight to Controlled Airports, and VFR through Controlled Airspace. The only one ATC service that is noticeably used less is VFR Flight Watch. Those most frequently selected ATC and related services that pilots would like Data Link to provide are: ATIS, NOTAMS/PIREPS, Weather Briefing, and VFR Flight Plan Filing.

ATIS, Weather Briefings, VFR Flight to Controlled Airports, and VFR through Controlled Airspace represent informational data as well as control instructions, whereas, those desired by Data Link represent informational data only. Therefore, GA pilots surveyed want Data Link to provide them informational data only and do not desire aircraft control instructions.

One reason for this distinction by pilots, may be that the GA pilot's workload is represented by the amount of information they need to attain and process, such as ATIS, NOTAMS/PIREPS, Weather Briefings, and VFR Flight Plan Filing. Data Link would provide pilots with a method of off-loading some of the information from their mental working memory (motor skills) to a system such as Data Link, and therefore, reduce their mental workload. Data Link would enable the pilot to retrieve, store, and recall information upon request.

Finally, of the three formats that Data Link information can be provided, pilot's preferences are divided between a CRT/panel format and printed paper copy.

6.2 COMPARATIVE.

The comparative assessment presented pilot's use of current ATC and related services with the pilot's desire to have the same services provided through Data Link.

6.3 QUALITATIVE.

The qualitative analysis indicated that pilots expressed opinions on two issues, economics and practicality. Both of these issues are important in the design, development, and implementation of a Data Link system to the GA community.

Economics:

The survey indicates that the concerns of the GA pilot are focused largely in part on the potential economic impact of implementing a Data Link system. Since the majority of pilots surveyed fly for personal use, it is likely, that they rely on personal income as the source for funding their flying. Assuming that the GA pilot is not gaining economic benefit from flight time, flight time represents a debt cost. The benefit from flying for the GA pilot is achieved solely from the intrinsic pleasure attained.

Conversely, management of a national air traffic system requires an economic perspective on a larger scale. The air traffic system derives its funding from governmental sources, therefore, there is not the same personal impact on funds as with the GA pilot.

It appears that the GA pilot surveyed balances cost against safety and the intrinsic pleasure gained from flying. Therefore, the GA pilot seeks to gain a personal level of benefit from money spent on flying. Whereas, governmental funding is focusing on producing a product to increase the benefit and safety across an entire sector of the air traffic system.

Practical:

In addition to economic concerns, the practicality of the system must also be considered. The benefits of integrating the user into the development process is essential to the production of a practical Data Link system. Respondent comments in the survey indicate that a practical system would include: two-way communication in both an audio and visual format, information that can be saved and retrieved when necessary, to maintain voice communication. Comments such as these demonstrate the need for educating pilots on Data Link and the development process. These pilots need to be informed as to what Data Link will change and how, before they can adequately assess a Data Link system.

Other comments made by pilots present issues that need to be addressed that involve actual effects on aircraft and pilot performance, such as maintaining situational awareness, knowing what other aircraft in the vicinity are doing and what their intentions are. In addition, also the effect of Data Link equipment on the aircraft weight limitations and performance parameters. Is the plane

going to support the equipment or vice versa? Will the plane be capable of housing the equipment?

Pilot's comments also suggested that the capabilities a Data Link system can provide are desirable and they anticipate the development of the system. However, pilots are concerned about the economics and practicality of the system. Specifically, whether or not the system will be designed and developed with the needs of the GA pilot in mind, as noted by a pilot "Don't over engineer this program."

7. CONCLUSION.

The results of this survey led to the following conclusions:

a. What services do general aviation (GA) pilots need via Data Link?

GA pilots' needs, with regard to Data Link, would have to be derived from what they desire (like/dislike) due to their low awareness of Data Link technology. GA pilots would like Data Link to provide them with Automated Terminal Information Service (ATIS), Notice(s) to Airmen (NOTAMS)/Pilot Reports (PIREPS), Weather Briefings, and visual flight rules (VFR) Flight Plan Filing.

b. How will these services be presented to the pilot?

Pilots surveyed prefer Data Link information presented on a cathode ray tube (CRT)/flat panel display equally to its presentation via printed paper copy. The determination of the format type is, however, one element of a multifaceted question of how information should be presented to pilots.

8. RECOMMENDATIONS.

The findings of the survey lend to the following recommendations due to the skeptical attitudes of pilots regarding the emerging technology:

a. As stated earlier, the feedback that was received in the comments section of the surveys and discussions with general aviation (GA) pilots indicate that there is a need to inform pilots on this emerging technoloqy.

First, there is a need for educating the GA pilot about Data Link. Pilots need to be informed about the operational aspects of Data Link; how it works, and how the user is integrated into the system.

Second, the GA community needs a demonstration of technology. Pilots are skeptical or at least reluctant to "buy into" an emerging system without a demonstration of the benefits of this emerging technology.

b. Comments suggested that a cost/benefit analysis needs to be conducted. Pilots want to know what the cost is to obtain the benefits of this emerging technology.

The focus of the cost/benefit analysis should address what is echoed by the GA pilot "Is it worth it." In order for pilots to determine whether the system is worth it or not they need to be given information regarding the functionality of the system and the associated cost, so they could make an informed decision.

c. The GA pilots surveyed would prefer Data Link information presented on a cathode ray tube (CRT)/flat panel display. This is, however, a very general requirement. There are a myriad of parameters that need to be determined and specified in order to develop an optimal presentation method.

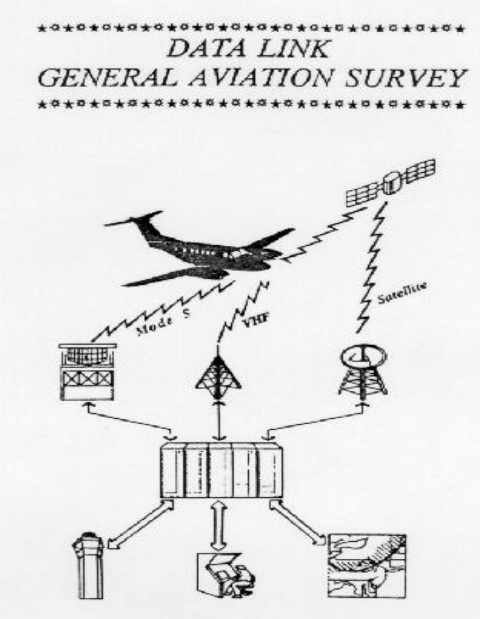
The determination of the necessary parameters needs to be addressed by the Federal Aviation Administration (FAA), avionics and airplane manufacturers, and the user community working together to ensure the development of an optimal Data Link system. Once an optimal Data Link display device is developed, certification will be necessary to ensure standardization of displays, display formats, and parameter specifications for avionics manufacturers.

d. There would potentially be greater acceptance of the system if the users were able to contribute in the development process of the system.

A cooperative effort needs to be established between the FAA, avionics and airplane manufacturers, and the user community. There would potentially be greater acceptance of the system if the user were able to contribute in the development process of the system. The GA pilot represents a unique sector of the flying community. Their reasons for flying are different than the air carrier, consequently their needs and concerns are different as well. The GA pilots expressed that they are made to follow mandated regulations created for the air carriers and that their concerns and needs are overlooked. Giving the user the opportunity to provide input in the design and development phases of a system, in addition to the FAA and avionics and airplane manufacturers, results in a system designed for their needs and could ensure user acceptance.

APPENDIX A

DATA LINK GENERAL AVIATION SURVEY



THE FAA TECHNICAL CENTER IS DEVELOPING A DATA BASE OF GENERAL AVIATION PILOTS REQUESTS FOR A NON-VOICE COMMUNICATION SYSTEM (DATA LINK).

DATA LINK PROVIDES TWO-WAY DIGITAL COMMUNICATION BETWEEN THE GROUND AND THE AIRCRAFT.

PLEASE HELP US BY PROVIDING YOUR INPUT ON HOW YOU WOULD USE THIS EMERGING TECHNOLOGY.

1. Certificates and ratings (Check [√] all applicable responses)

Student pilot
Private pilot
Commercial pilot
Airline transport pilot

Instrument -- airplanes
Instrument -- helicopter

Rotorcraft
Single engine
Multi engine
Sea Plane
Lighter than air

2. Flight Experience (check [√] appropriate box)

HOURS	0-300	301-1000	1001-pluS
Total time			
Last 12 mos. _____(approx.)			

3. What is the primary area of your <u>current</u> involvement in aviation (check [√] one response)?

GA -Personal Use
GA -Commercial/Flight Instr.
GA -Business
Air Carrier
Military
Air Traffic Control
Other Specify

4. Are you an aircraft owner? Yes No

5. Which of the following FAA air traffic control and related services do you routinely use (check [√] all applicable services)?

VFR to Controlled Airports
VFR through Controlled Airspace
VFR Flight Plan Filing
VFR Flight Watch
VFR Flight Following
Weather Briefing
NOTAMS/PIREPS
ATIS
IFR OPERATIONS
Other _____

(OVER)➳

6. Data link technology allows ATC communications and selected services that are normally transmitted over voice circuits to be digitized. The digitized information is transmitted via ground-based station or satellite to the aircraft, where it is received and stored in a digital format.

Data link facilitates faster transmission of the information, and eliminates many of the errors inherent in voice communication. Information can be stored in receiver memory and retrieved later on a CRT display, printed paper copy, or voice synthesizer.

If the technology necessary for data link communications was available, how would you rate the desirability of obtaining the following air traffic control and related services by data link?

*** Rate each item by checking [√] appropriate box, 1 to 5:**

1 = Strongly Like	**2 = Like**	**3 = Neutral**	**4 = Don't Like**	**5 = Strongly Dislike**
	1	**2**	**3**	**4**	**5**
VFR to Controlled Airports					
VFR through Controlled Airspace					
VFR Flight Plan Filing					
	1	**2**	**3**	**4**	**5**
VFR Flight Watch					
VFR Flight Following					
Weather Briefing					
	1	**2**	**3**	**4**	**5**
NOTAMS/PIREPS					
ATIS					
IFR Operations					

7. What format would you prefer the Data Link information to be displayed (check [√] one response)?

CRT
Printed paper copy
Potentially voice synthesizer.

8. Comments:

_____

_____

APPENDIX B

PILOT COMMENTS

A) Practical

While I am strongly in favor of the new Data Link system, I believe voice-to-voice communications should exist at least at one point in the process (i.e., Weather briefing is voice-to-voice or flight watch is voice-to-voice).

Data Link could eliminate the pilots ability to see "the big picture" in an instrument flight rules (IFR) environment. Weather broadcasts, NOTAMS, and flight plan filing and even IFR ground clearances should be okay.

There must always be a human element inherent in air traffic control and flight service stations to ensure that clearances, weather, etc. are completely and totally understood by the pilot.

Regarding IFR operations, the pilot cannot lose the ability to know what other aircraft in the vicinity are doing.

B) Economical

Cost to aircraft owner?

I would like it inexpensive

Sounds expensive

C) Display Format

Electronic on-line flight plan filing would be nice. On-screen depiction of clearances/instructions as well.

CRTs can break very easy and can be hard to read in the sun. Paper is easy to read (thermal paper is not a good choice), and voice synthesizers are no good and can be annoying.

Please, help put CRTs in cockpits whereby all Air Traffic Information Service (ATIS) or other information (NOTAMS) is instantly and completely pulled up on the screen without a delay.

Although printed paper can be messy, searching for information on a CRT could be potentially dangerous.

Being able to see clearances and weather on a CRT or a printed copy would simplify matters, and eliminate mistakes.

CRT with all data links displayed highlighting links for that specific aircraft.

A CRT with printer would be best. This would allow reference back to earlier clearances, weather, etc.

Voice synthesizer would be best, primarily because of cost to the general aviation community.

Hard copy and CRT, there should be a hard copy in case of mistakes or system failure.

D) General

I consistently get weather briefings and file flight plans using DUAT, and find it far superior to verbal communication with FSS.

Spend less on technology and hire some people who give a damn and know what they are doing.

Less automation and more skilled people (FSS and ATC), you can't beat a pair of eyes.

B-2

APPENDIX C

FIGURES

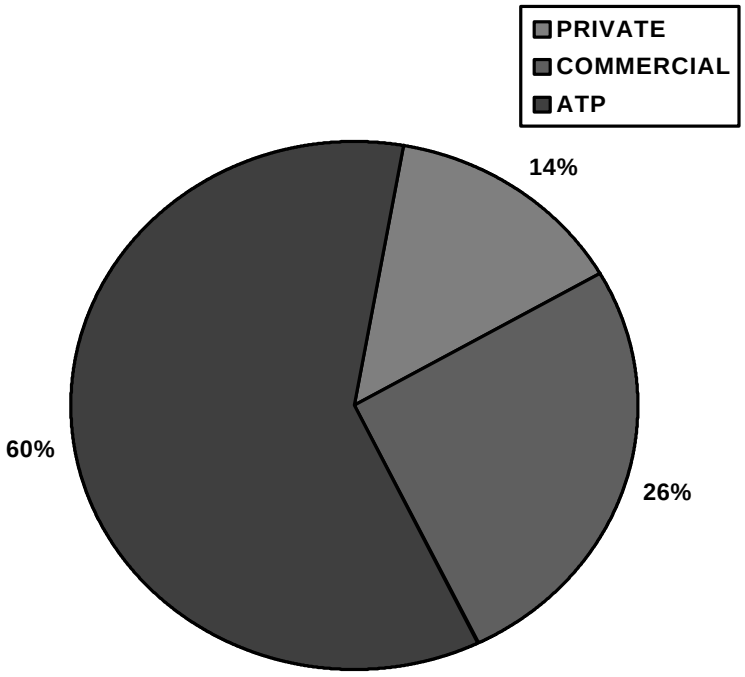


FIGURE 1. PILOT CERTIFICATION

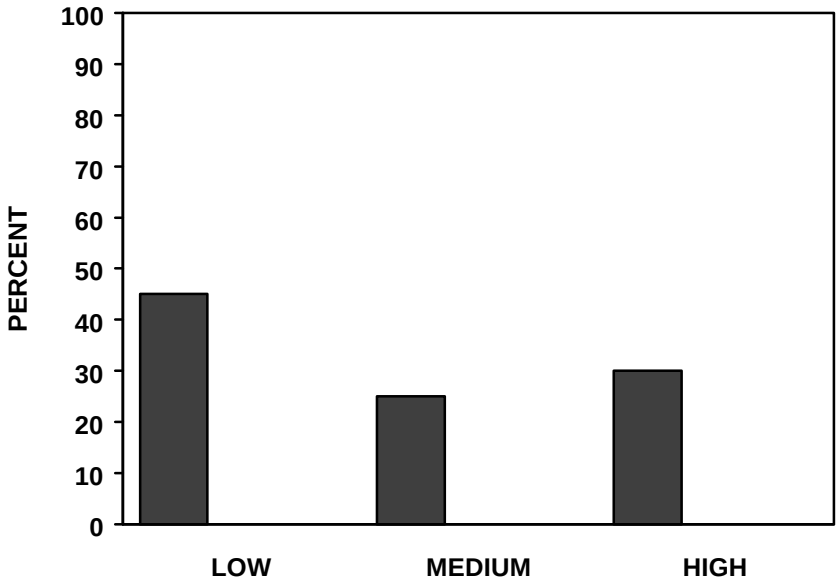


FIGURE 2. PILOT FLIGHT EXPERIENCE

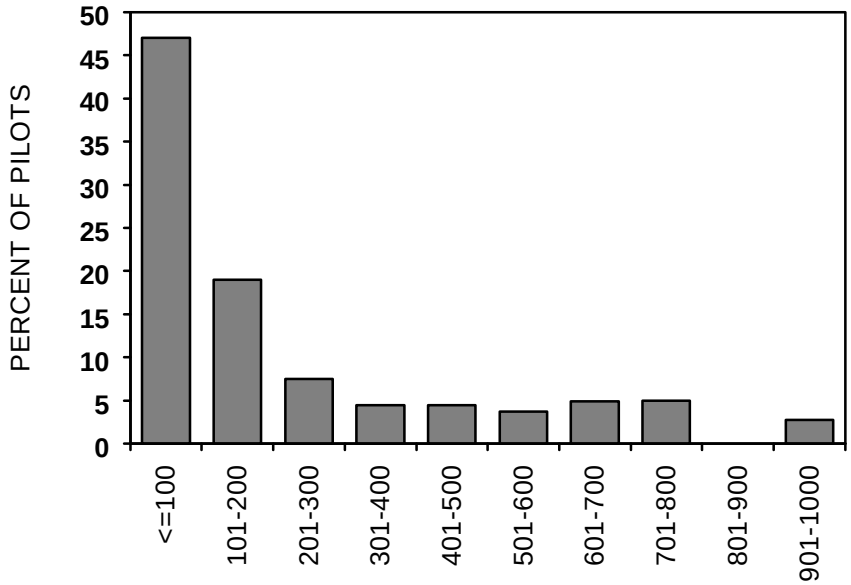


FIGURE 3. FLIGHT TIME DISTRIBUTION

C-3

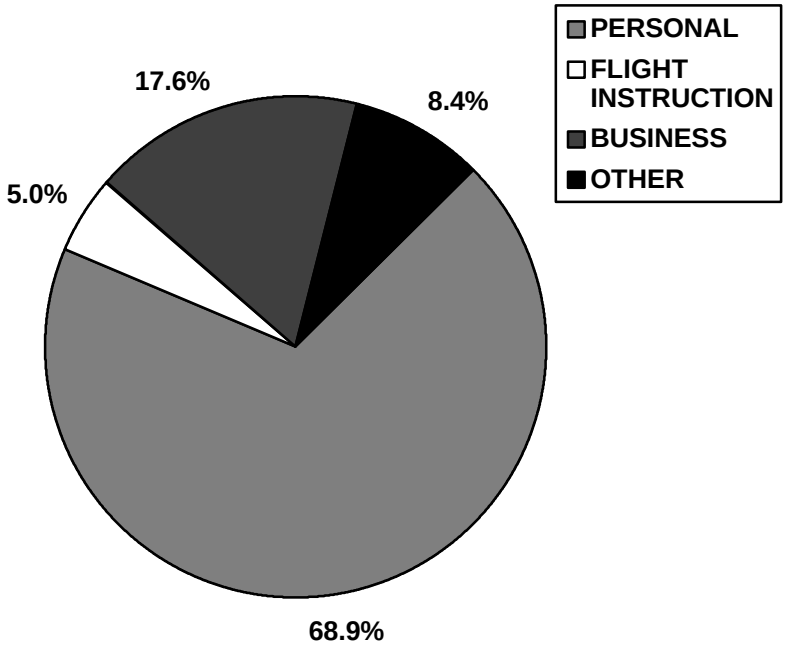


FIGURE 4. CURRENT INVOLVEMENT IN AVIATION

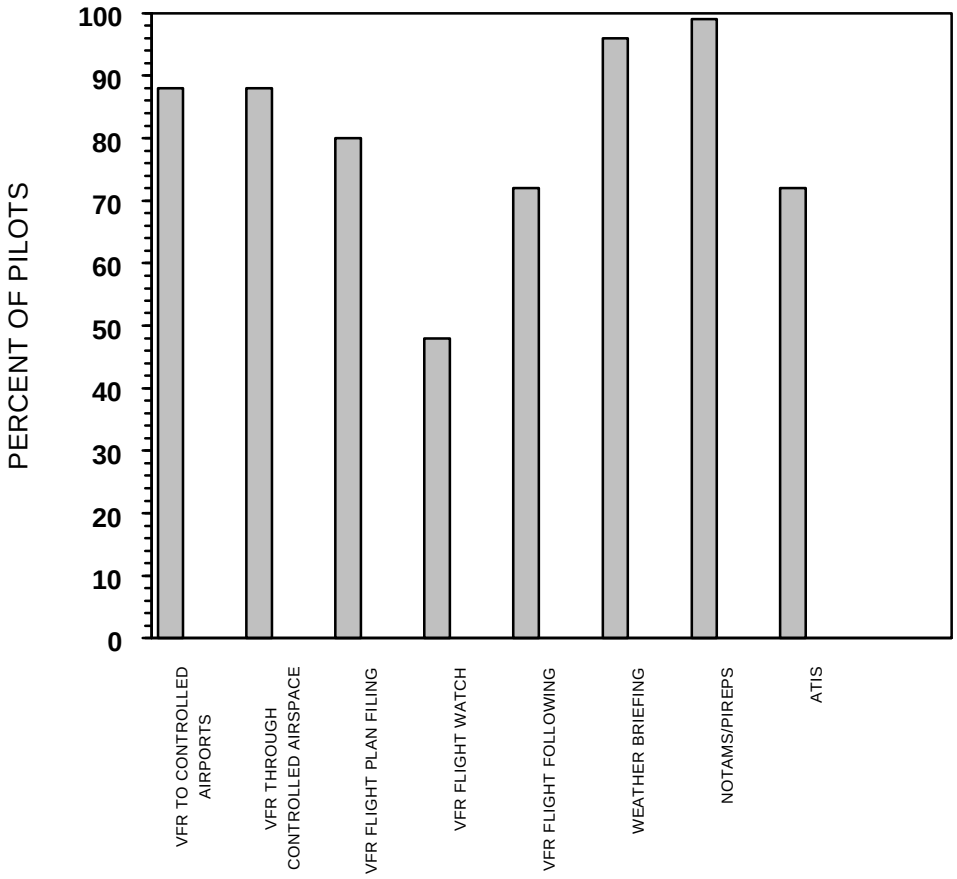


FIGURE 5. CURRENT ATC AND RELATED SERVICES

C-5

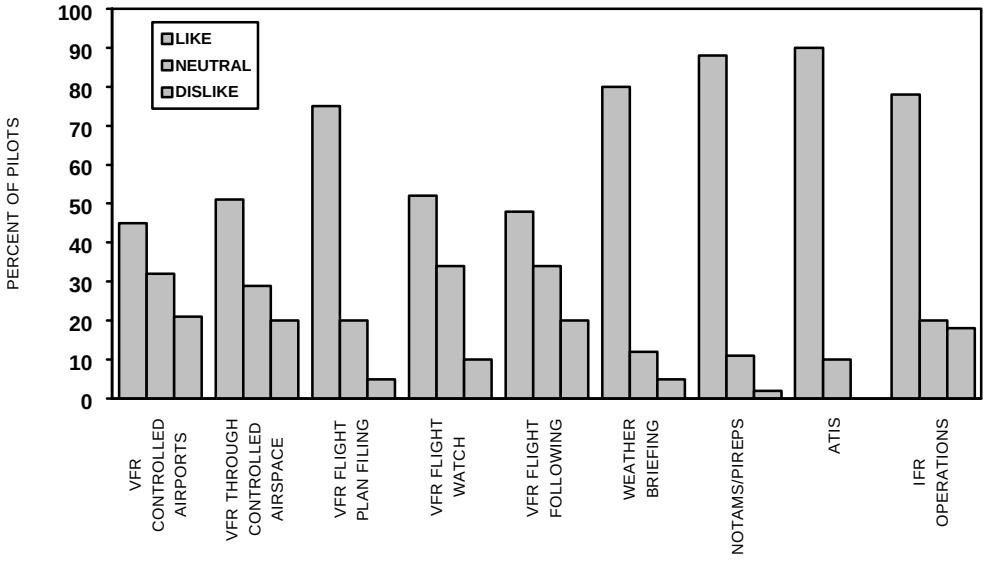


FIGURE 6. PILOT PREFERENCES FOR DATA LINK